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Review

Chemical constituents, experimental and clinical pharmacology of *Rosa damascena*: a literature review

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Abstract

Context *Rosa damascena* Mill. is prescribed for the management of chest and abdominal pain, constipation, digestive disorders, menstrual bleeding and liver ailments.

Objective The current review compiles up to date and complete information of whole plant of *R. damascena* with particular emphasis on its numerous scientifically proved pharmacological effects, traditional and folk medicinal uses.

Key finding The data on the pharmacological effects of *R. damascena* were collected from various databases such as PubMed, Wiley Online Library, Elsevier and Web of Science using the keywords like phytoconstituents, pharmacology, medicinal uses and biological activity of *R. damascene*. *Rosa damascena* has a wide spectrum of bio-pharmacological activity like antidepressant, hypoglycaemic, anti-inflammatory, analgesic, antioxidant and antimicrobial. The main ingredients of *R. damascena* essential oil responsible for pharmacological activity are geraniol and citronellol. Its uses have been widely accepted in traditional system of medicines for the management of numerous diseases of human beings in different dosage forms.

Summary *Rosa damascena* has a significant place in traditional system of medicine. It is cost-effective and an important plant with curative application in contemporary medicine. Further studies on the characterization of chemical constituents and scientific basis of pharmacological activity of *R. damascena* should be carried out to evaluate its impact on traditional system of medicines. Large-scale preclinical and clinical trials will be beneficial in investigating the mechanism of the therapeutic potential of *R. damascene* to explore its uses in pharmaceutical industries.

Introduction and history

Rosa damascena Mill. is commonly known as Damask rose that is flower's king[1] and is the sign of inspiration, purity, love, happiness and beauty. It is an ornamental and a precious herb with modern pharmacological importance, which are used in medicines.[2,3] There are 18 000 cultivars and more than 200 species of *Rosa* around the world.[4] Since 7th century A.D., the extraction of essential oil from *R. damascena* was originated from Iran. It is famous not only because of its medicinal or pharmacological effects but also have holy believes. It is labelled as Gol-E-Muhammadi (the flower of Prophet 'Mohammad') by the people of Iran[5] because its fragrance reminds them of the prophet

Muhammad ﷺ. Essential oils are mainly produced by Bulgaria and Turkey, and the best one is Bulgarian *R. damascena* oil. On global market, *R. damascena* oil is expensive because 242 000 rose petals are needed to purify approximately 5 ml of rose oil.[6] Pakistan introduced the 71% phenylethyl alcohol, the key component of rose oil.[7] Research suggested the existence of the species of rose plant about 40 million years ago.[8] About 5000 years ago, the humans recognized the rose, as indicated by past reports. Akkadian king (2684–2630 BC) reported that the king bought the rose seedlings across the Tigris River during his military campaign, because he lived close to Babylon, and his trip was possibly to Southeastern Anatolia. Rose is the most important, useful and popular plant, so the number of presently existing cultivars is not possible to discover. Twenty-four Rosa species grow in the East Aegean Islands and Flora of Turkey.[9] The rose petals, flowers and heads are useful in medicines as they help many parts of the body including ears, eyes, tonsils, gums, head, mouth, chest, stomach, rectum and uterus, which is written by Pliny the Elder (23–79 CE).[10] In Indian traditional Ayurvedic medicines, rosebuds are considered as cephalic tonic, cardiac and astringent properties. Petals are applied locally for oral ulcers and are used to treat uterine haemorrhage.[11] The Royal Library contained over 600 books on rose and rose cultivation.[8]

Ibn-e sina, the great physician, was the earliest scientist that highlighted the advantages of rose scent on brain and heart. Positive effects of rose water on brain were also observed by Ibn-Al-baitar. Eşref bin Muhammad (15th century CE) suggested in his book *Haza'inü's-Saa'dat* (*Treasures of Happiness*) that food prepared with rose water is the most appropriate food for babies.[12] For industrial purposes, *R. damascena* flowers are used immediately after harvesting and should handpick early in the morning.

Rosa damascena is just about 1–2 m in height and a perennial bushy shrub with life span up to 50 years. The flowers are bright and large. The orientation of leaves is odd pinnate with 5–7 leaflets.[[13],[14]] *Rosa damascena* (Rosaceae) is a shrubby plant, with numerous unequal strong prickles, dilated at the base; with 5–7 leaflets, ovate, stiffish; flower-bud oblong, sepals deflexed after the flowers have opened; tube elongated, often dilated at the top; fruit ovate, pulpy; calyx and peduncles glandulosely hispid, and viscous; with light red flowers. This plant is used in treating erectile dysfunction, cardiovascular disorders and respiratory tract infections.[15] It also cures constipation and increases intestinal movements. It has anti-inflammatory, antibacterial and anti-HIV activity.[16] The antifungal activity of *R. damascena* has been reported.[17] The drug is used against all types of hepatitis and jaundice.[18] It is used as a cosmetic agent,[19] deodorant and disinfectant, and is useful in renal disorders and osteoarthritis.[20] This plant reduces toxicity induced by Levodopa in patients with parkinsonism.[21] *Rosa damascena* is one of the most famous ornamental plants for perfume industries. In addition to perfuming effect, it has several pharmacological properties including antioxidant, astringent, antibacterial, antimicrobial, anti-inflammatory and analgesic.[20] This plant is used for the treatment of menstrual bleeding, abdominal pain, chest infection and as laxative agent in constipation. Intensity of pregnancy-related lower back pain decreases by rose oil as compared to carrier oil because it improves the functional ability. Essential oil of *R. damascena* contains main components geraniol and citronellol, which are responsible for pharmacological activity. There are different products of *R. damascena* available in the market including Gulkand (jam of rose), rose oil, rose syrup, rose water and rose tea, and each product has its own benefits and importance. This paper reviews the pharmacological investigations on *R. damascena*. Pharmacological activity of *R. damascena* has been documented that will help the physicians to understand therapeutic uses of this important medicinal plant (Table 1).

Chemical constituents

Phytochemicals

Isolated petals of *R. damascena contain* anthocyanins, terpenes, flavonoids and glycosides.[22,23] It contains myrcene,[24]

Table 1 There are different forms of *Rosa damascena*

Rose water	It is the colourless water, which is called as Gulaab in Iran due to its relaxing, soothing and calming properties. It is the abundant product, which contains 10–50% rose oil. It has antiseptic, antibacterial, anti-inflammatory, antioxidant, laxative and anti-ageing properties[66]
Rose essential oil	It is the pale, yellow and semisolid oil extracted by various profitable methods. It is expensive because it provides only one part of oil out of 3000 parts of flowers. The main producers of rose essential oil are Turkey and Morocco
Dried flowers	There are two kinds of dried flowers (1) Dried bud for export (2) Dried petals for different functions. The key use is for ingestion because it solves the digestive troubles like gulkand (rose petal preserve). The other reason for drying the flowers is to store them and use them later on for distillation[3,84]
Rose hips	Under the petals of flower, the berry-like fruit is rose hip. It is rich in minerals, vitamins, tannins, polyphenols, carotenoids and fatty acids. In rose hips, the content of vitamin C is higher than citrus fruits[85]
Other products	Hydrosol, absolute chloroform, ethanol and aqueous extraction from the hips, petals and flowers are the other products[86]

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carboxylic acid,[25] kaempferol, quercetin[26] and vitamin C. Flower contains fatty oil, tanning matter and organic acids. In the essential oil of *R. damascena*, more than 95 micro and macro components were found by Loghmani-Khouzani. Geraniols (5.5–18%), β-citronellol (14.5–47.5%) and nonadecane (10.5–40.5%) were discovered compounds, and nerol and kaempferol were the major constituents of the oil.[27] Investigation of absolute rose reveals that heneicosane, ethanol (0.00–13.43%), geraniol (3.71%), citronellol (9.91%), nonadecane (4.35%) and phenylethyl alcohol (78.38%) are the major components.[28] Hydrosol was also found to contain four components that are nerol (16.12%), phenylethyl alcohol (23.74%), citronellol (29.44%) and geraniol (30.74%) as the major compounds.[28,29]

Flavouring compounds that are present in the *R. damascena* essential oil are β-damascone, β-ionone and β-damascenone, usually obtained from carotenoid degradation.[30] Phosphorus, calcium, sodium, potassium, magnesium, iron, manganese, boron and zinc are the mineral contents of *R. damascena*. Phenolic compounds are mostly responsible for medicinal functions of Rosaceae, which are present in large amount. Wide range of pharmacological activity is shown by phenolics such as antimutagenic, antioxidants, anti-inflammatory, anticancer, free-radical scavenger and antidepressant.[31–33]

Aliphatic components, alkaloids, anthocyanins, α-cadinol, α-santalene, α-selinene, β-bisabolol, β-citronellol, β-citronellol trimethylsilyl ether, β-gurjunene, β-linalool, β-patchoulene, β-selinene, γ-cadinene, benzoic acid trimethylsilyl ester, Bis-(trimethylsilyl)-1,2 butanediol, bourbonene, carboxylic acid, carbohydrates, cadinene, caryophyllene, carotene, cis-rose oxide, citronellol, citronellyl formate, citronellyl-n-butyrate, ÿamascene, docosane, eicosane, elemene, elemol, eugenol, eugenol methyl ether, farnesol, flavonoids, fatty oil, gallic acid, geraniol, geraniol trimethyl ether, germacrene D, geranyl acetate, geranyl isobutyrate, geranyl propionate, globulol, glycosides, 4-βH, 5a-eremophil-1(10)-ene, 11-trimethylsiloxy, heneicosane, heptadecane, humulene, hydrosol, ionone, 2-isopropyl-5-methylcyclohexyl ester, kaempferol, linalool, methyl octadecane, 2-methoxy-4-1 (1-propenyl) phenoxy] trimethyl silane, methyl abietate, 1-methyl-pimar-7-en-8-oate, monoterpenes, myrcene, nerol, nerol trimethyl ether, n-hexacosane, n-hexyl benzoate, n-nonacosane, n-octacosane, n-octadecanol, nerol, nonadecane, nerolidol, organic acids, oxalic acid, decyl 2-phenyl ester, patchouli alcohol, 2,2,4,7,7 pentamethyl-3,6-dioxa-2,7-disilaoctane, pinene, phenylethyl alcohol, 2.2 phenylethyl trimethylsilyl ether, proteins/amino acids, quercetin, quercetin, quercitannic acid, rhodinol, sabinene, saponins, sesquiterpenes, stearoptene, T-cadinol, tannins, terpenes, terpineol, T-cadinol, thymol, 2,2,11,11 tetramethyl-3,4,10-trioxa-2,11-disiladodecane, tetradecanol, trans-cadina-1,4-diene, trans-2-hexyl-n-octanoate, trans rose oxide, trimethylsilane, 1-γ-eudesmol, viridiflorol and vitamin C are the important phytoconstituents of *R. damascena*.[34] Some of the chemical constituents of *R. damascena* are shown in Figure 1.

Flavour compounds

Essential oil of *R. damascena* contains β-damascenone, β-damascone and β-ionone that are usually obtained from degradation of carotenoid.[30]

Mineral contents

Phosphorus, potassium, calcium, magnesium, sodium, iron, copper, manganese, zinc and boron are found in *R. damascena*.[35]

Medicinal uses

It is nervine tonic prescribed in depressive patients. A herbal formulation known as Gulkand is formulated from rose flowers, which is useful in constipation. It elevates mood and prevents depressive effects.[36] It has antistress activity and is used in nervous tension. It is also effective in gastric ulcer and cardiovascular diseases. It helps in digestion and increases bile production. It cures the uterine disorders and high blood pressure.[31,37] Flowers contain different vitamins including vitamins A, B3, C, D and E. It is used in stress, nervous tension and depression. Gulkand (rose petal preserve, rose petal jam) is the herbal formulation from rose petals, which is useful in constipation and used as a laxative.[36] Rose flowers contain number of vitamins including A, B3, C, D and E. Rose tea helps to fight against the infection of digestive system and bring back the usual bacterial population of intestine. It is used to cure painful and irregular periods. It relieves uterine congestion causing pain and heavy bleeding. *Rosa damascena* also used in cosmetics, creams, hand lotions and perfumes. The famous Iranian scientist Avesina extracted the *R. damascena* essential oil in 10th century to treat various diseases. The decoction of flowers in Iranian traditional medicines was used for curing abdominal and chest pain, digestive illness and menstrual bleeding, and the decoction of dried flowers is used for lowering the fever, menstrual problems and breast pain and suggested as diuretic.[38] When petals of rose are cooked with sugar and honey, it relaxes the mind and body with cooling effect. Iranian people used the rose hips with bread because it is an approved blood purifier. Rose water was also used for mouth disinfectant[39] and for eye washing[40] because it is an antiseptic agent, also used for bronchial and chest congestions because of its antispasmodic activity. Other different pharmacological activity is mentioned in Tables 2 and 3.

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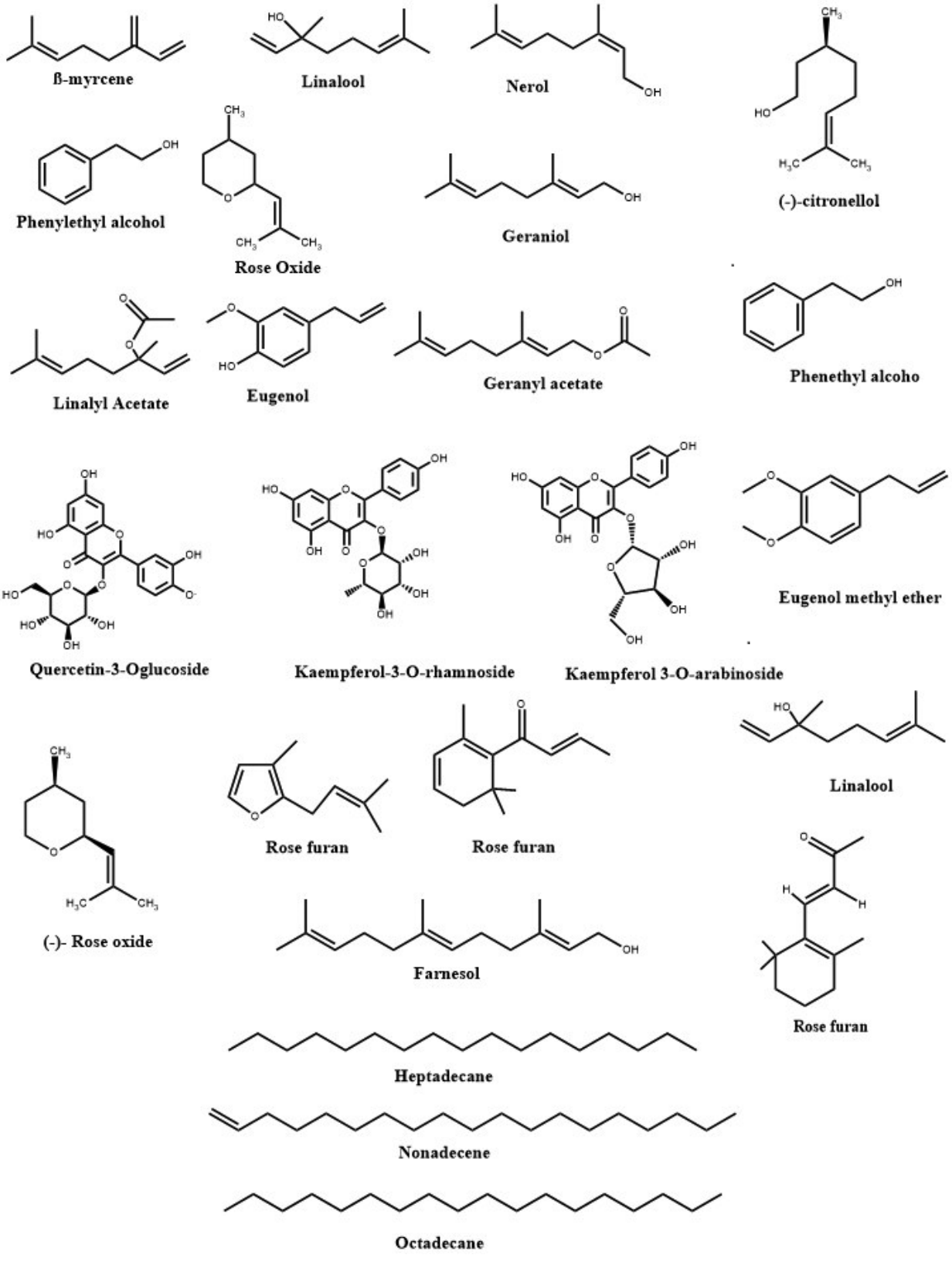

Figure 1 Some of the chemical constituents of *Rosa damascena*.

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Table 2 Pharmacological activity of *Rosa damascena*

Types of extracts or essential oil	Activity shown	Technique	Reference
Herbal eye drop contains extract of *R. damascena*	Ophthalmic disorder	Clinical investigations	[68]
Fresh flower juice	Hepatoprotective	Antioxidant activity test	[87]
Rosebuds contain Cyanidin-3-O-B glucosides	Cardiovascular role	ACE (angiotensin-converting enzyme) inhibitor	[37]
Extract of chloroform	Neuroprotective, cure of dementia	Testing of neurite growth	
Phenylethyl and essential oil	Neuroprotective, enhance memory	Obstruction against acetylcholine esterase (ACHE)	[88]
Essential oil	Anticonvulsant	Seizures in rats are induced by Pentylenetetrazol (PTZ)	[50,89]
Essential oil	Antimicrobial	Well diffusion, Disc, microdilution methods	[28,90]
Flavonoid compounds	Anti-HIV	Effects on H9 human T cells chronically infected with 1IIIB and C8166 human T lymphoblastoid cells in HIV-1MN	[51]
Methanol extract	Antilipase	Porcine pancreatic lipase reduce the turbidity of a triolein	[44]
Methanol extract	Reduce diabetes	Capacity of α glucosidase action	[45,91]
Ethanol extract (*R. centifolia*)	Relieve cough	Sulfur dioxide gas induces mouse model	[49]
Hydro alcohol, essential oils and ethanol extracts	Antioxidant	Scavenging activity of free radicals	[47,92]
Ethanol extract	Anti-ageing	Death rate in adults Drosophila flies	[93]
Ethanol extract	Antisolar	SPF determination	[70]
Ethanol extract	Constipation laxative	Rats by intraperitoneal injection and gavage	[82]
Aqueous or ethanol extract	Anti-inflammatory	Carrageenan induce rat paw size	[15,58]
Ethanol extract	Bronchodilator	Inhibit calcium channels of guinea pig tracheal chain	[82,94]
Aqueous or ethanol extract	Antitussive	Citric acid method	[61]
Aqueous or ethanol extract	Potentiating of contractility and heart rate	Isolated pig heart	[56]
Extract of aqueous and ethanol	Analgesic	Acetic acid, hot plate, tail flick and formalin test	[64,95]
Aqueous or ethanol extract	Hypnotic	Pentobarbital-induced sleep time	[96]

This table shows the different pharmacological studies of *R. damascena*.

Pharmacological activity

Rosa damascena has been reported to have a wide range of pharmacological activity due to the presence of a variety of active phytoconstituents. These constituents are biologically active substances responsible for the functional medicinal properties of the plant. Some of the activity of *R. damascena* have been shown in Figure 2 and discussed in the manuscript text below.

Experimental studies

Antimicrobial effect

Multiple studies published in the literature reported antimicrobial activity of *R. damascena Mill*. having significant phenolic contents such as phenylethyl alcohol, flavonoids and terpenoids.[41] Anti-acne effect of *R. damascena* essential oil against *Propionibacterium acnes* has been reported in a study conducted by Zu *et al*.[42] Absolute, hydrosol and essential oil are the important products of *R. damascena* that has the antimicrobial activity. Absolute and essential oil of *R. damascena* have potent antibacterial activity against *Erwinia*, *Staphylococcus aureus*, *Chromobacterium violaceum*, *carotovora*, *Bacillus subtilis*, *Pseudomonas aeruginosa* and *Escherichia coli strains. E. coli* and *C. violaceum* were most sensitive to absolute and essential oil of *R. damascena*. The absolute rose has antimicrobial action against both Gram-positive and Gram-negative bacteria.[28] Batool *et al*.[43] in their study reported antilisterial activity of *R. damascena* when investigated the antimicrobial activity of this plant against *Listeria monocytogenes* using albino mice.

Antidiabetic activity

Reduction in blood glucose level is seen by the oral administration of *R. damascena* methanol extract. It inhibits the postprandial hyperglycaemia comparable to acarbose. Enzyme α-glucosidase is strongly inhibited by *R. damascena*, which slows down the carbohydrate absorption from small intestine and results in antidiabetic effect by decreasing the effect of postprandial glucose level.[[44],[45]]

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Table 3 Pharmacological activity through experimental studies

Activity	Dosage form	Dose	Model/cells	References
Anti-inflammatory	Hydroalcoholic extract	250, 500 and 1000 mg/kg	Mice	[56]
	Hydroalcoholic extract	250, 500 and 1000 mg/kg	Rats	[97]
Antidepressant	Aqueous extract	20 and 40 mg/kg	Mice	[98]
Immunoregulant	Methanol extract	10, 50, 100 μg/ml	Peripheral blood mononuclear cells (PBMC)	[99]
Anticonvulsant	Aqueous extract	100, 500 and 1000 mg/kg	Mice	[100]
	Hydroalcoholic extract	50, 100 and 200 mg/kg	Rats	[101]
	Hydroalcoholic extract	200 and 400 mg/kg	Rats	[102]
Gastro-protective	'VARD' formula consisting of *Rosa damascena* Mill. (Rosaceae)	45 mg/kg	Rats	[103]
Antihypertensive	Hydroalcoholic extract	250, 500 and 1000 mg/kg	Rats	[104]
Nephroprotective	Aqueous extract	250 and 500 mg/kg	Rabbits	[105]
Relaxant	Essential oil	2.5–160 μg/ml	Rats	[106]
Hepatoprotective	Aqueous extract	250, 500 and 1000 mg/kg	Rats	[46]
Hypnotic activity	Ethanol and aqueous extracts	500 and 1000 mg/kg	Mice	[95]
	Hydroalcoholic extract	250 and 400 mg/kg	Mice	[107]

Hepatoprotective activity

A study was conducted to evaluate the hepatoprotective potential of aqueous extract of *R. damascena* flowers on acetaminophen-induced toxicity in rats. Oral administration of N-acetyl-p-aminophenol (2 g/kg) resulted in alteration of different biochemical parameters such as hepatic lipid peroxidation, creatinine, urea, bilirubin, albumin, lactate dehydrogenase, serum alkaline phosphatase, serum transaminase and reduced glutathione levels. Oral administration of *R. damascena* at dose of 250, 500 and 1000 mg/kg b.w. resulted in reversing these values in a dose-dependent value.[46]

Antioxidant effects

In vitro inhibitory effect on lipid oxidation and antioxidant effect of *R. damascena* showed that the effect is similar to tocopherol and causes strong antioxidant and lipid peroxidation inhibitory effect. This plant is suggested for the treatment and prevention of diseases caused by free radicals.[47,48]

Both the fresh and spent flowers (dead or dying flowers) have the antioxidant activity, but the extract of fresh flowers has more antioxidant activity as compared to the extract of spent flowers.[49] In ethanol extract, the presence of phenolic compound showed high antioxidant activity.[50]

Antilipase effect

In one study, the antilipase effect of the extract of *R. damascena* has been investigated. Ethanol extract of *R. damascena* has antilipase activity. Antilipase activity of this plant has been reported in literature.[51]

Anti-HIV effects

Rosa damascena water and methanol extracts showed average anti-HIV action. The nine compounds, which were isolated from methanol extract, have the antiviral activity and the study on these compounds showed that the crude extract anti-HIV action is due to the joint effect of these compounds, which acts against various stages of viral replication. *Rosa damascena*'s water and ethanol extracts were studied against HIV infection *in vitro*. In this study, 2-phenylethanol-O-β-D-glucopyranoside, filtered from methanol extract of *R. damascena*, was assessed on H9 human T-cell and C8166 human T lymphoblastoid contaminated with HIV-1IIIB and HIV-1MN. It reduces the viral activity and works permanently with gb 120. Kaempferol 1 has immense action against C8166 cells of HIV infection. It reduces the maturation of infectious progeny virus by slowing down the viral protease. Derivatives of kaempferol avoid the binding of gp120 to CD4 to inhibit HIV infection.[26]

Effect on patient with Alzheimer's disease

Several studies investigating the efficacy of *R. damascena* on the central nervous system (CNS) have been published in the literature. This plant has a large effect on the central nervous system. A study shows that the ethanol extract of flowering tops of *R. damascena* has strong suppressive effect on the CNS in mice. CNS depressant effect of *R. damascena* results in enhancing the memory.[52,53] Memory impairment is one of the main manifestation of Alzheimer disease in elderly people.[54] Five per cent people of above 65 years are suffering from Alzheimer disease. In early stage of Alzheimer disease, hippocampus is damaged. Process of memory and learning is associated with

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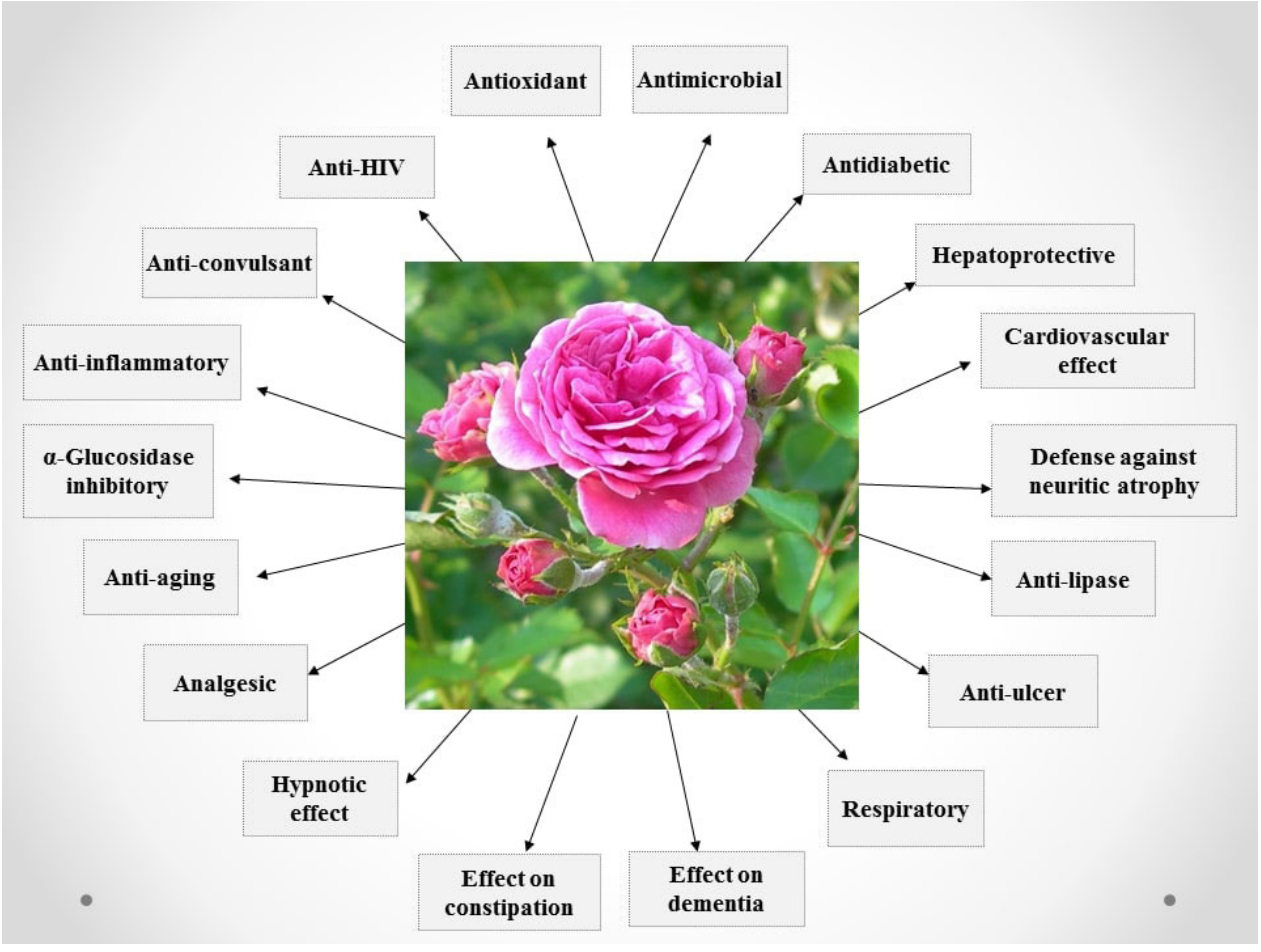

Figure 2 Various pharmacological activity of *Rosa damascena*. [Colour figure can be viewed at wileyonlinelibrary.com]

hippocampus. Dementia occurs due to loss of synapses and neurons in Alzheimer disease. Synaptogenesis and neurogenesis may be the preventive target for Alzheimer's disease. A study was conducted to investigate the *R. damascena* for its potential for synaptogenesis and neurogenesis. This study was conducted in animal model of Alzheimer's disease. The study showed that *R. damascena* has ability to induce synaptic plasticity and neurogenesis and enhances memory in Alzheimer disease. This study shows that *R. damascena* can be used as therapeutic agent in patients with Alzheimer disease.[54]

Anticonvulsant effect

Hosseini[55] conducted a study to investigate the antiseizure activity of *R. damascena*. Mice that selected for study had seizures, which induced by pentylenetetrazol. Mice were divided into different groups. One group was treated with normal saline. Second group was treated with *R. damascena* extract, and third group was treated with diazepam. All forms of treatments were administered intraperitoneally. These doses were administered before giving the injection of pentylenetetrazol. Parameters for assessment were mortality rate, generalized tonic–clonic seizure and first minimal clonic seizure. There was significant decrease in these parameters by use of *R. damascena*. This study indicated that *R. damascena* is useful in PTZ-induced seizures, but further study is needed to know the exact mechanism of action.[55]

Alpha-glucosidase inhibitory activity

A study was conducted to investigate the alpha-glucosidase inhibitory activity of *R. damascena* flowers in comparison with usually used alpha-glucosidase inhibitor acarbose. Normal and diabetic rats were selected for study. *Rosa damascena* was found effective in inhibiting the alpha-glucosidase. This inhibition by *R. damascena* was noncompetitive. Extract of *R. damascena* was given orally at a dose of 100–1000 mg/kg body weight. Significant hypoglycaemic

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activity of this plant was observed after administration of maltose in normal and diabetic rats. This study showed that *R. damascena* has antidiabetic activity due to inhibition of carbohydrate absorption from the intestine and is useful in hyperglycaemia.[45] Figure 3 depicts a scheme of inhibiting activity of *R. damascene*.

Effect on inflammation

Rosa damascena has anti-inflammatory activity. Analgesic and anti-inflammatory activity of essential oil and hydroalcoholic extract of *R. damascena* was investigated by administering the extract orally at dose concentrations of 250, 500 and 1000 mg/kg bw. Essential oil was used at dose of 100, 200 and 400 μl/kg bw. Acetic acid was given intraperitoneal to induce writhing response. Formaline was used to induce paw licking. Rats were used for anti-inflammatory activity via carrageenan-induced paw oedema. Writhing response was attenuated by extract. Analgesic activity was also observed by use of extract. Carrageenan-induced oedema was reduced by higher doses of extract. This study showed that *R. damascena* has anti-inflammatory activity and it can be used as therapeutic agent in inflammatory diseases.[56] Due to the presence of vitamin C, *R. damascena* has anti-inflammatory and antioxidant activity.[56] Carrageenan investigated the anti-inflammatory effect of hydroalcoholic and essential oil extracts of *R. damascena* on rat paw oedema. The results showed that only at a dose of 1000 mg/kg remarkably decreases the paw oedema in rat, whereas no anti-inflammatory action is shown by the essential oil of *R. damascena* on even all administered doses.[57,58]

Analgesic effect

Chloroformic, aqueous and ethanol extracts of *R. damascena* were examined in mice on tail flick and hot plate method and reported that analgesic effect is shown by only ethanol extract.[56] In formalin test, the antioxidants decrease the pain[59] and the flavonoids present in the *R. damascena* are responsible and have some role for this analgesic effect.[60] Kaempferol and quercetin are also responsible for the analgesic effect, which is not soluble in water.[[61],[62]] The study was conducted to investigate the potential of topical rose oil for alleviating pregnancy-related low back pain in women. Total number of women having low back pain was 120 that were divided into three groups. First group received topical rose oil and second group received placebo (carrier oil), and there was no intervention with third group. After 4 weeks of treatment, all groups were assessed for intensity of pain and its impact on daily activity. There was significant improvement assessed by Roland-Morris disability questionnaires and visual analogue scale in the patient treated with topical rose oil than placebo and no intervention groups. Significant reduction in intensity of pain was observed in topical rose oil-treated patients than other groups. Rose oil alleviated the pregnancy-related low back pain without any significant side effect.[63]

Hypnotic effect

On central nervous system, *R. damascena* has the hypnotic or soothing effect. In mice, 500 and 1000 mg/kg dosage of chloroformic, aqueous and ethanolic extracts of *R. damascena* were used to observe the hypnotic effect that considerably increased the sleeping time induced by pentobarbital in mice, which was related to the effect of diazepam. The result shows that except chloroform the other two extracts have the hypnotic effect.[[56],[64]] Another study showed that the phenobarbital-induced sleeping time is increased by ethyl acetate, n-butanol and aqueous extracts. The best hypnotic effect was observed in ethyl acetate. Terpenes and flavonoids are the components of *R. damascena*.[13] Researches prove that these compounds have hypnotic effect.[[65],[66]] Several studies have shown that the flavonoids act as antidepressant and relieve anxiety.[67] It has the hypnotic effect due to their attraction for the central benzodiazepine receptors. Hypnotic efficacy of *R. damascena* has been reported. Aqueous, ethanol and chloroform extracts were used for study. This study was conducted by using rats. Efficacy of extract was based on its ability to potentiate the pentobarbital-induced sleeping time by extracts. This study was conducted in comparison with diazepam. Dose of diazepam was 3 mg/kg that was used as positive control. Extract was given at three doses such as 100, 500 and 1000 mg/kg bw, intraperitoneally. Saline was used as negative control. Pentobarbital at dose of 30 mg/kg was injected after 30 min of injection of extracts. Sleeping time was noted. Study showed that aqueous and ethanol increased the pentobarbital-induced sleeping time. Effective dose of extract was 500 and 1000 mg/kg. Effect of aqueous and ethanol extract was comparable to diazepam. Hypnotic activity by chloroform extract was not observed.[64]

Anti-ageing effect

In published studies, *Drosophila melanogaster* mortality rate was assessed by rose flower extracts, which showed major decrease in mortality rate in flies. Without disturbing physiological mechanisms, *R. damascena* extended Drosophila life period. Furthermore, anti-ageing effects were also observed. The study suggested that due to antioxidant property of *R. damascena*, the life period of Drosophila is prolonged.

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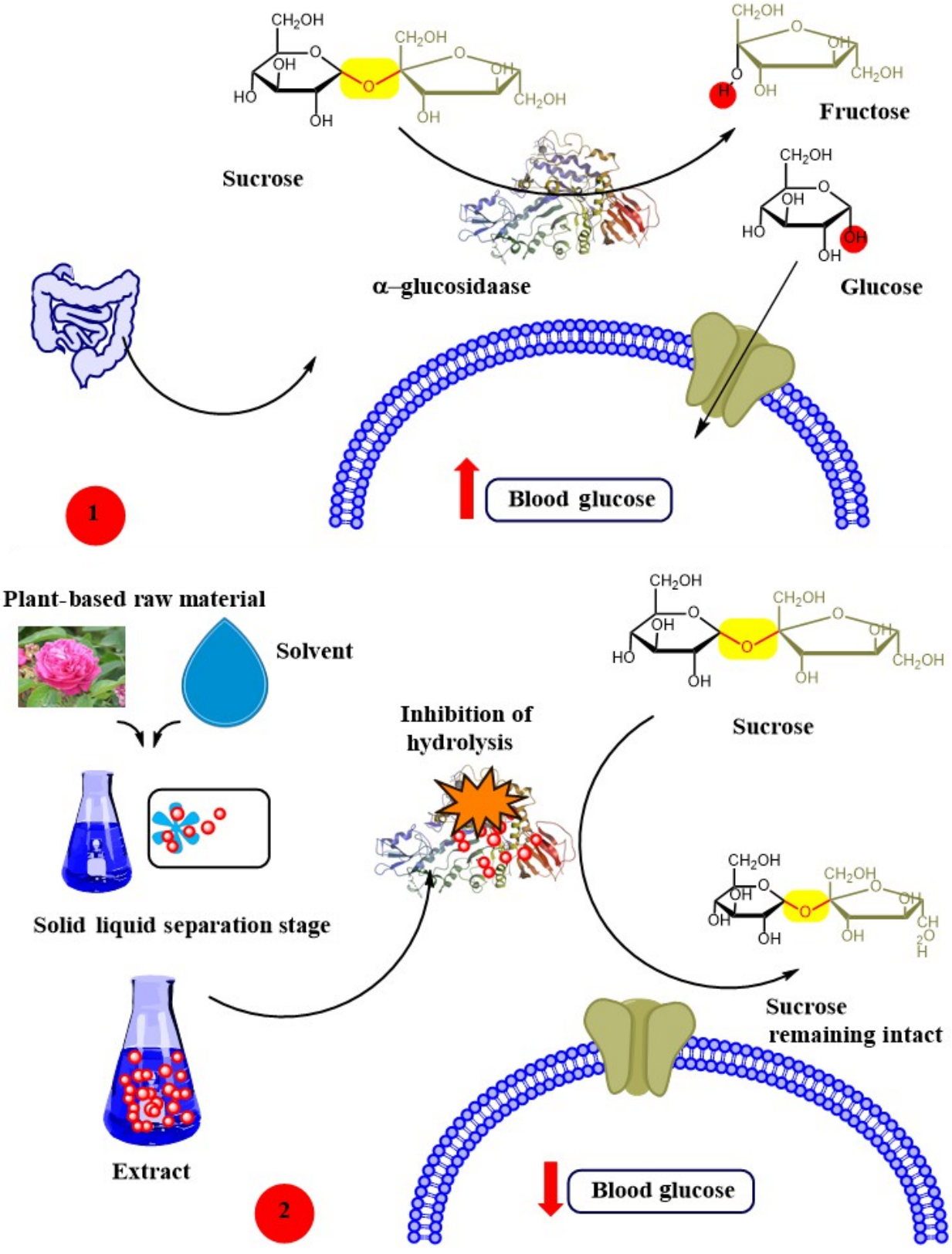

Figure 3 Scheme of alpha-glucosidase inhibiting activity of *Rosa damascene* extract. [Colour figure can be viewed at wileyonlinelibrary.com]

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Optic effects

Herbal eye drop of *R. damascena* was examined in several ophthalmic disorders including conjunctival xerosis, post-operative cataract, conjunctivitis and acute dacryocystitis. Improvement was seen in many cases because of its anti-inflammatory and anti-infective properties. It plays an important role in recovering various infective and inflammatory ophthalmic disorders.[68]

Effect on intra-abdominal adhesions after laparotomy

Inhibitory potential of *R. damascena* on adhesion after laparotomy was investigated rats as experimental animals. Total number of thirty healthy rats was divided into three groups. First group was treated with 1% of *R. damascena* extract and second group was treated with 5% of *R. damascena* extract, while third group was used as control that received 3 ml of distilled water. Anaesthesia was administered for opening of abdominal wall. Three shallow incisions of 2 cm were created on the right wall, and peritoneal surface (2 × 2 piece) was dissected on the left part of the wall of abdomen. Then, 3 ml of *R. damascena* 1% and 5% was introduced into the abdominal cavity and 3 ml of distilled water was administered into abdominal cavity of control group. Suturing of abdominal cavity was done, and after 14 days, second laparotomy was carried out to the created adhesions. The adhesion amount in first group treated with 1% of *R. damascena* extract was significantly lower than control group treated with distilled water. There was significant reduction in fibrosis and inflammation in 1st group as compared to control group. All rats in second group treated with 5% *R. damascena* were found dead. Study showed that 1% *R. damascena* reduces intra-abdominal adhesions in animal model. Further studies are required to verify its efficacy to treat such disorders in human model.[69]

Effect on constipation

The gastrointestinal disorders like constipation are treated by *R. damascena*. *Rosa damascena* boiled extract increase the water content and frequency of faeces and exerts its laxative effect by osmotic infiltration of fluid into the intestinal lumen because intraperitoneal injection shows the symptoms of constipation in first 24 h.[70]

Rosa damascena flower has been used for treatment of gastrointestinal disorders, that is constipation.[70–72] A study was conducted to investigate the effect of *R. damascena* on ileum motility. Hydroalcoholic extract of plant growing in Iran was used for study. Organ bath containing Tyrode's solution was used for the suspension of a section of rat ileum. Acetylcholine, KCL and electrical filed stimulation were used to stimulate the tissue. Effect of hydroalcoholic extract of *R. damascena* was investigated on ileum contraction induced by Ach, KCL and EFS in comparison with atropine. Rat-isolated ileum was contracted at dose of 10–100 mg/ml of *R. damascena*, and relaxant effect was observed at dose of 1 mg/ml of *R. damascena* extract. Ilium contraction induced by Ach, KCL and EFS was inhibited by hydroalcoholic extract of *R. damascena* at dose of 1–8 mg/ml. There was no significant effect of vehicle observed on contraction of ilium. Author concluded that *R. damascena* has stimulatory effect on smooth muscle of ileum at dose of microgram concentrations and has inhibitory effect at dose of milligram concentration. This difference in concentration and its effect on ileum smooth muscle with regard to its concentration may be due to the presence of different ingredients in the hydroalcoholic extract of *R. damascena*. Stimulatory effect of *R. damasecna* validates its use as laxative agent in treatment of constipation.[73] Prokinetic and laxative activity of *R. damascena* has been reported. Rats were used for the study. Fourteen rats were divided into two groups test and control. Boiled extract was given to test group. The water percentage, weight and number of faeces were noted up to 24 h. In test group, number and percentage of faeces were increased and content volume was increased in jejunum as compared to placebo group. This study indicated the laxative activity of *R. damascena* that may be attributed to osmotic infiltration of fluids into the intestine.[70]

Clinical studies

Effect on dementia

Dementia is a worldwide problem affecting most of population in old age.[74] Drugs that activate outgrowth of neuritis might induce neuronal reconstruction, and as a result, function of brain is recovered. In previous study, neuritis outgrowth activity was induced by chloroform extract of *R. damascena* and Aβ (25–35)-induced atrophy and cell death was inhibited. An active compound having molecular formula $C_{37}H_{64}O_2$ was isolated from *R. damascena*. This compound was able to protect Aβ (25–35)-induced atrophy. Furthermore, strong neuronal outgrowth activity was observed after treatment with this compound. Study indicated that *R. damascena* can be used in dementia.[75]

Effect on primary dysmenorrhoea

The published studies investigated the efficacy of *R. damascena* in patients with primary dysmenorrhoea. In a study conducted in Tabriz University of medical sciences in Iran on 92 students under the age range of 18–24 years. BMI of

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patients was 19–25. Visual analogue scale was used for pain intensity score. Students were divided into two groups with 46 students in each group. *Rosa damascena* and mefenamic acid were given to participants. Drugs were given to study subjects for 3 days after every 6 h. Through questionnaire and visual analogue scale, data were collected. SPSS was used for statistic analysis. There was no significant difference in intensity of symptoms in both treatment groups. Both drugs were found similar in activity. *Rosa damascena* being a natural and safe drug can be suggested in primary dysmenorrhoea.[76]

Anticonvulsant effect

Stages of seizure are decreased by the injection of rose oil. The essential rose oil lessens the period of tonic–clonic seizures and slows down the start of epileptic seizures in rats with acute pentylenetetrazole (PTZ)-induced seizure.[77] It indicates that the flavonoids present in essential rose oil may be responsible for this effect because in the brain it takes action on GABAergic system, and on GABA receptors, it also increases the effect of benzodiazepines. The exact mechanism of these compounds is unknown. Antiepileptic activity has been shown in other components of *R. damascena* oil like eugenol and geraniol.[78] The children with unmanageable seizures are treated with essential oil of *R. damascena* as supplementary. It decreases the rate of seizures in those patients who were using rose essential oil. Therefore, helpful antiepileptic effect of essential oil of rose has shown in children with unmanageable seizures.[79] *Rosa damascena* is used in patients with epilepsy.

Defensive effect against neuritic atrophy

Rosa damascena exert beneficial effects on brain functions like for curing the dementia. Awale *et al.*[75] discovered that chloroformic rose extract inhibited the amyloid β (Aβ) and influences the neurite outgrowth activity. Major pathological cause of Alzheimer disease is thought to be Aβ, produced in the Alzheimer patients, which is the main fragment of full peptide of Aβ[[28],[80]] and causes the neural cell death, memory loss, neuritic atrophy and synaptic loss.[81]

Cardiovascular effect

Effect of *R. damascena* on cardiovascular disorder is little. Aqueous-ethanol extract of *R. damascena* in guinea pig heart increases the contractility and heart rate. Exact mechanism is unknown.[16] From the buds of *R. damascena*, cyanidin-3-O-β-glucoside is found which slows down angiotensin 1-converting enzyme (ACE) action and improves the cardiovascular role because ACE is an important enzyme for angiotensin II production.[37]

Effect on respiratory system

In guinea pigs, cough induced by citric acid is deceased by ethanol and aqueous extracts of *R. damascena*.[82]

Effect on aphthous ulcers

A randomized, double-blind, placebo-controlled study was conducted to investigate the efficacy of *R. damascena* in aphthous ulcers. Parameter for assessments was pain, size and number of ulcers. Assessment of parameters was done on days 4, 7, 11 and 14 in test and placebo group. At baseline, there was no significant difference in parameters. After treatment, significant difference was observed and *Rosa damascena* extract was found more effective than placebo.[83]

Conclusion

Rosa damascena is the vital species of Rosaceae family mainly famous for its perfuming property and in addition to that it has many uses and pharmacological activity. The main product of *R. damascena* is rose water and its oil. Several constituents are present in the *R. damascena* including flavonoids, anthocyanins, terpenes and glycosides, which have useful effects on body. The investigations confirmed that the *R. damascena* has anti-inflammatory, antioxidant, antiviral, antimicrobial, analgesic, antibacterial, anticonvulsant, antidepressant, anticancer, relaxant and hypnotic effects. It is used for many digestive problems like constipation and as laxative. Eye drop of *R. damascena* is very useful in ophthalmic disorders. Pharmacological activity mentioned in this article showed that *R. damascena* has the potential to cure hepatitis and a promise for future therapeutic interventions. The literature reveals that this plant has a remarkable hepatoprotective activity. Recent scientific studies of *R. damascena* have been confirmed the antilipase, anti-Alzheimer disease, antiseizure, alpha-glucosidase inhibitory, antidysmenorrhoeal, anti-inflammatory, analgesic, hypnotic, antidementia activity and laxative effects. Documented medicinal activity presupposes the importance and sheds some light based on its use in Unani and folklore. Further detailed phytochemical screening and biological activity studies need to be conducted to understand its antiviral activity and the development of new drugs so that hepatitis in the world can be addressed.

Declarations

Conflict of interest

The Authors declare that there is no conflict of interest.

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